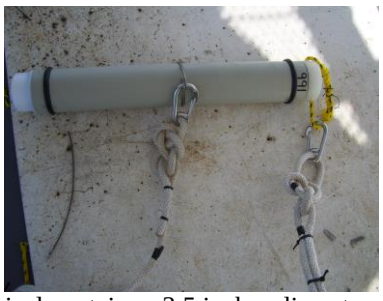
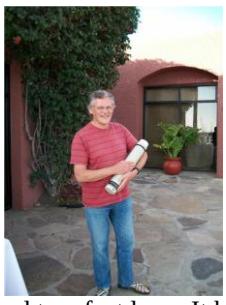
First Report of Acoustic Research

October 5th, 2015

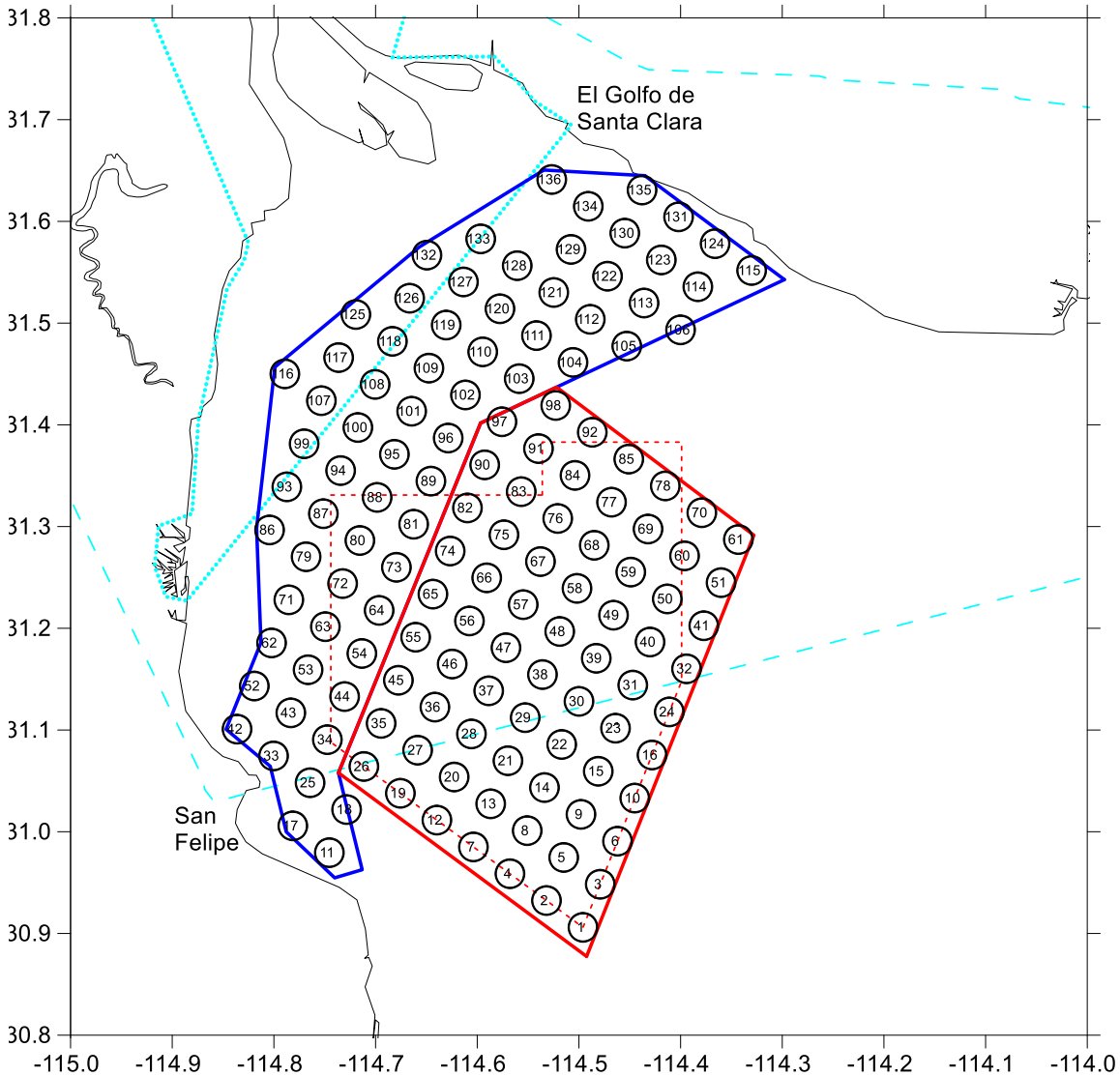
Expedición Vaquita 2015 was formally started with the arrival of the Research Vessel *Ocean Starr* to San Felipe, and the boarding of chief scientists and observers on September 26th. October 1st was a very interesting and important date in the history of conservation of vaquita, when SEMARNAT Secretary, Rafael Pacchiano, Governor of Baja California, Francisco Vega and Commissioner of Fisheries and Aquaculture, Mario Aguilar, in company of other dignitaries, were able to sight three vaquitas. It is the first time that high level authorities have seen with their own eyes Mexico's vaquita!

Although the expedition was formally initiated the last week of September, design and implementation tasks were started months ago. To detect the sounds emitted by vaquita we use passive acoustic detection electronic equipment. Contrary to sonars that produce an acoustic signal and receive its rebound, passive detectors only passively "hear" clicks produced by vaquitas or other similar species. These clicks are produced at high frequencies, far higher than the hearing range of humans. The clicks can be detected with hydrophones and electronics specifically designed for porpoise detection. For the expedition we use autonomous acoustic detectors called C-POD (http://www.chelonia.co.uk/), which are able to work without the assistance of any human operator. The inventor of the C-POD, Nick Tregenza from Great Britain, has been closely involved in the project since 2008. The objective is, hence, deploy them and leave them working for several days and then retrieve them to download stored information.

The C-POD is a rigid plastic cylindrical container, 3.5 inches diameter and two feet long. It holds inside an electronic module and room for ten D-size batteries. In the non-opening extreme is a capsule that holds the hydrophone. In the right photo is Nick Tregenza, the inventor of C-POD, holding the very first C-POD (serial number 1) in a meeting in Mexico.

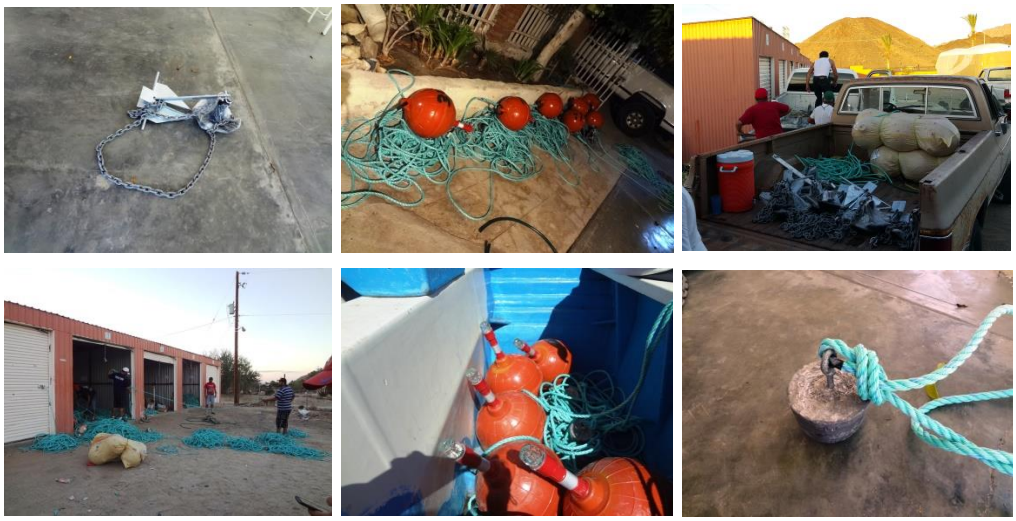
The acoustic component of the expedition is key to gather data on vaquita density in shallow waters. The acoustic sampling design has a grid of 136 sites, 67 in the shallow zone of the distribution area where only acoustic data will be gathered. The other 69 sites are in the calibration area, where the comparison of visual and acoustic data will allow us to estimate the calibration factor to "translate" acoustic data to abundance in shallow area.



Map of a portion of the Upper Gulf of California, showing the position of San Felipe and El Golfo de Santa Clara. Blue lines delimit the Biosphere Reserve (fine broken nuclear zone and thick broken buffer zone). Red broken line is the Vaquita Protection Refuge. Black circles and labels are the positions of acoustic sampling sites. Red polygon shows the calibration area and blue one the shallow area.

To keep in place the acoustic detectors (C-PODs) at the sampling sites moorings are needed, which were designed to prevent equipment loss,

resisting severe oceanographic and weather conditions with winds likely up to 50 knots. The mooring is a couple of anchors, one river type where C-POD is attached and other Danforth type, used as a safety measure in strong currents. A polystrong rope is used to connect anchors with a rigid plastic buoy, light colored (for visibility during daylight hours) and equipped with a strobe light, visible from 3 nm away. A 10 Kg weight is attached at a point in the rope where C-POD is fixed, in order to hold it at a fixed depth as it has positive floatation.



Images showing diverse aspects of moorings constructed to hold acoustic detectors (C-PODs) in place on sampling sites. It is shown the anchors pair, buoys equipped with strobe lights and the rope connecting anchors and buoy. It is shown also some members of the team in assembly duties, as well as a truck to transport the moorings and the ones prepared already in the boat ready to be deployed.

To diminish the drag on the buoy by currents, moorings were designed to have the connecting rope three times larger than the maximum depth at the sampling site. The tidal range is extreme in these waters, sometimes more than 10 meters. Therefore, each sampling site had to be measured for depth and corrected against tide tables. The minimum depth recorded at site 136 was less than 1 meter, so equipment was not deployed there. The greatest depth recorded was over 40 meters. With this information moorings were assembled with the proper rope length for every sampling site.

The field operations group (fishermen belonging to the Cooperativa Islas del Golfo, San Felipe, Baja California) has six deployment/retrieval teams, equipped with an outboard engine fiberglass boat (called panga in Mexico) and a crew of two or three. The same fishermen assembled the moorings according to the specifications for each site and also organized the gear in

the boats to work efficiently according to day's plan. The first C-POD was deployed on September 26th and the activity continued until October 3rd, when the last one was deployed. In approximately 20 to 30 days we will complete the first round of C-POD interchange, retrieving the deployed detectors and replacing them with other ones with fresh batteries and empty memory cards. This maximizes the amount of data because lost C-PODs can be replaced and data analysis can begin during the expedition. Preliminary results will be given in these Reports.

In addition to assembling the moorings a great deal of work and care was devoted to initializing the C-PODs. First, 10 D-size batteries are secured with a metal clip, designed to hold contact even under severe motions by currents, so that C-PODs can keep collecting data. The C-POD has a clock system that measures time, but is not a clock itself. This system function like a chronometer in a watch, by depressing a button it starts counting the time, no matter what time of day it is. That is why it is necessary to register the precise time when a C-POD is initialized, so we can determine the precise time when a vaquita was detected. We needed to do this for the 135 C-PODs deployed and will need to repeat this on every interchange period until December, when the expedition finishes.

Simulating vaquitas to improve interpretation of acoustic data

Although the distribution of vaquitas is too small compared to other cetaceans, the Upper Gulf still exhibits a variety of depths and oceanographic conditions that could affect the distance at which vaquitas can be detected. C-PODs in shallow water are both closer to the surface and breaking bubble sounds and to the bottom with sounds from snapping shrimp and sediment impacts. To understand potential differences in detection distance for different depths, we are using artificial high frequency clicks to recreate vaquitas under different depths. We are taking care to produce clicks as similar as possible to clicks produced by vaquitas.

Artificial clicks are produced using a signal generator, a precision instrument able to produce high definition signals up to 25 million of cycles per second, well beyond the frequency of porpoises below 200,000 cycles per second. The generator produces these signals with low power, so an amplifier must be used like pumping up the volume on a radio, CD or MP3 player. The click emission system uses a hydrophone, which has the ability not only to

perceive sounds, but also to produce them at the required porpoise-like frequencies.

So far, we have been able to produce clicks detectable by C-PODs up to 150 meters away. The first step was to produce artificial clicks that are identified and stored at the correct frequencies. Pulses emitted at regular intervals resemble echo-sounders, like the ones used by fishing boats. Not surprisingly, our first artificial click series, emitted at regular intervals, were detected and identified by the C-PODs as echo-sounder signals. We have redesigned the system include a triggering system and created software designed to produce clicks with modulated interval times to match those of vaquitas. We will test the improved system soon and expect to produce clicks series identified as vaquitas by C-POD with no ambiguity. Results to be reported here soon.


Armando Jaramillo reviewing the artificial click emission system. In the image it is possible to observe the signal generator and a portion of the amplifier (lower left), as well as and the computer running the generator controller software. In the right is Gustavo Cárdenas holding the structure use to keep hydrophone in a vertical position (black device in the tip of the structure).